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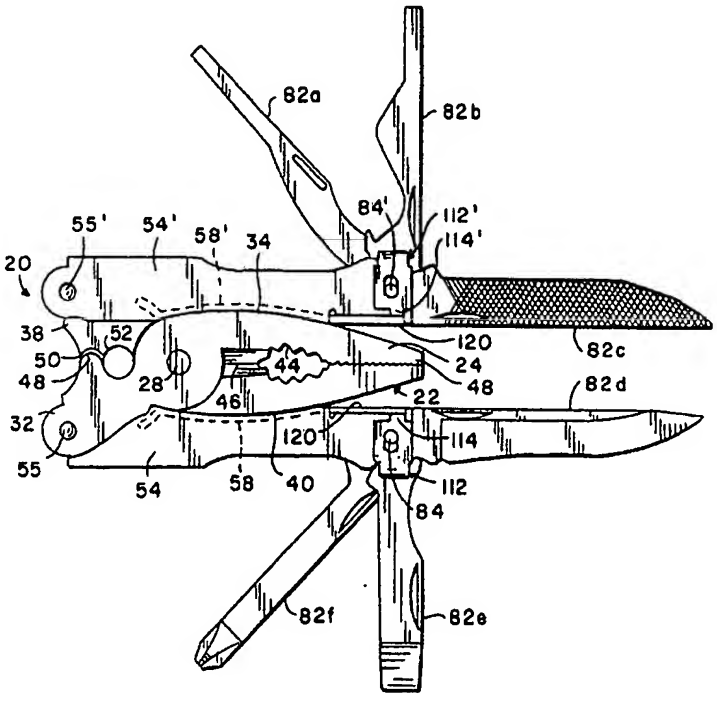
(54) Title: MULTI-PURPOSE HAND TOOL INCLUDING IMPLEMENT POSITION LOCKING AND RELEASE MECHANISM

(57) Abstract

A combination tool (20) including a pliers jaw mechanism (22) and two handles (56, 56') that pivot about the lugs (32, 38) of the jaw mechanism (22) between open and closed positions. The externally facing surfaces of the handles (56, 56') are dished to conform to the sides of the jaw mechanism when the handles (56, 56') are closed. The jaw lugs (32, 38) include cam surfaces over which corresponding surfaces of the handles ride to provide detents for the handles in the open and closed positions. The handles each house multiple blades (82), each independently rotatable on a common axle (84) between a closed position within the handle and an open position extending from the handle. Each blade (82) is positively but releasably locked into its open position. Those blades which remain closed are biased toward the closed position when the opened blade is locked into position and also as it is opened and closed. A single locking, releasing and biasing mechanism (108) serves all of the blades in one handle.



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MULTI-PURPOSE HAND TOOL INCLUDING IMPLEMENT POSITION LOCKING AND RELEASE MECHANISM

BACKGROUND OF THE INVENTION

This invention relates to hand tools with foldout blades, and, more particularly, to such hand tools with multiple foldout locking blades.

Hand tools with multiple deployable blades have long been known and used in the home, in the workplace, and in sporting applications. A folding pocket knife having two blades is an example. The blades are carried inside a handle for storage, and are selectively opened, one at a time, when required to perform specific functions.

Pocket knife-like devices, such as those produced by Wenger and Victorinox and commonly called "Swiss Army" knives, use this same principle extended to a plurality of tools carried within the body of the knife on axles located at either end of the knife. Such implements typically incorporate a variety of types of blade-type tools, such as one or more sharpened blades, a screwdriver, an awl, a file, a bottle opener, a magnifying glass, etc. Generally, Swiss Army knives are designed to be sufficiently small and light for carrying in a pocket and are therefore limited as to the strength and robustness of their structure.

In recent years, devices known generically as "combination tools" have been developed and widely marketed. Such combination tools typically include a jawed mechanism such as a pliers or a scissors, and deployable handles having implements pivotally folded into the handles. The implements may include slot screwdrivers, Phillips-head screwdrivers, knife blades, can openers, awls, and the like. The implements are folded into the handles for storage or when the jaw mechanism is to be used, and pivoted open as necessary. Designs and features of combination tools have been extensively patented. Combination tools are available commercially from a number of manufacturers, such as Buck Knives, SOG, Leatherman, and Gerber. These combination tools are used by a variety of persons, such as repairmen, outdoorsmen, handymen, and hobbyists. The combination tools, while of

about the same size, are mechanically more robust than the multi-bladed knives generally known as "Swiss Army" knives. The combination tools have substantial jaw mechanisms, and, at least in some cases, the fold-out implements may be positively locked into place to avoid unintended closing and injury to the user.

One useful feature of some conventional folding knives is the ability to positively lock the blade in the open position to prevent an unintentional closure during service that could cut the hand of the user. Lockbacks, sidelocks, axle locks, and other types of locks are known in the art. Another useful feature is the biasing of the blade toward its closed position from angular orientations close to the closed position. Such biasing acts as a detent to prevent the blade from unintentionally folding open when carried or when another blade is already open and in use. The blade may also be biased toward its open position from angular orientations close to the open position. In either case, the biasing effect gives a secure feel to the closing and opening of the blades. Cam, backspring, ball detent, and other types of biasing structures are known in the art.

Positive locks used in conjunction with biasing structures are desirable features of knives, and have recently been utilized in knives having multiple blades rotating in the same direction on a common axle. (When the term "blade" or "blade tool" is used herein in reference to deployable tools received into the handle of a combination tool, knife or other type of tool, it refers to any relatively thin tool that is folded into the handle, regardless of the utilization of the tool. Such a "blade" therefore includes, but is not limited to, a sharpened knife blade, a serrated blade, a screwdriver, an awl, a bottle opener, a can opener, a saw, a file, etc.) Existing approaches have internal structures that require a great deal of space when adapted for use on several side-by-side blades, or the locking release controls take up too much space or are inconvenient. For example, a typical combination tool has three, four or more blades folding from a common axle in each handle, where the width of the handle --the required envelope size within which the entire structure must fit --is on the order of about 1 inch or less. The sides of the handle, the blades, and any locking and biasing mechanism must fit within that width, and an externally accessible lock releasing structure must also fit on the outside

of the handle within that width. If the width of the handle of the hand tool is increased significantly above about 1 inch, the combination tool will no longer be comfortable in the hand.

There is a need for an approach to locking and biasing multiple, side-by-side blades of combination tools, knives, and other types of hand tools where the blades pivot on a common axis. The present invention fulfills this need, and further provides related advantages.

SUMMARY OF THE INVENTION

The present invention provides a hand tool wherein multiple blades pivot on a single axle. The blades are each positively locked into their open positions by a single locking mechanism. The blades are also biased toward their closed positions and their open positions. When one blade is opened, the others stay in their closed positions. The opened blade is positively locked and later unlocked without moving the other blades from their closed positions. In a preferred form of the invention, the hand tool is a handle of a combination tool having a pair of handles deployably joined to a jaw mechanism. The combination tool embodying the invention is suited for attachment to a key ring or the like, but is also permits the use of a nut-grasping feature in a pliers head. The handles are sculpted for comfortable grasping during service. The handles are provided with convenient detents in the closed and open positions.

In accordance with the invention, the hand tool comprises a tool body having a pair of oppositely disposed sides, an axle extending transversely between the sides of the body at one end of the tool body, and a plurality of blades supported on the axle. Each blade includes a base having a peripheral surface and an implement extending outwardly from the blade base, and further has a bore through the blade base with the axle extending through the bore so that the blade base and thence the blade is rotatable on the axle between a closed position wherein the blade is contained within the tool body and an open position wherein the blade extends from the tool body. There is a notch in the peripheral surface of the blade base. A locking mechanism is slidably movable relative to the axle and includes a locking bar

that engages the notch of the blade base when the blade is in the open position. The locking mechanism further includes means for biasing the locking bar into engagement with the peripheral surface of the blade base, wherein the biasing means comprises a portion of the tool body.

There is, additionally, means for biasing one of the blades toward the open position while biasing all others of the blades toward the closed position. This biasing means preferably takes the form of a first cam surface on the peripheral surface of each blade base at a location adjacent to the notch, having a first cam maximum surface height and a first cam maximum surface height angular position, and a second cam surface on the peripheral surface of the blade base at a location remote from the notch, having a second cam maximum surface height and a second cam maximum surface height angular position located about 110 to about 120 degrees from the first cam maximum surface height angular position. The first cam maximum surface height is preferably about the same as the second cam maximum surface height.

Thus, the invention provides a locking/biasing mechanism that positively locks any one of the blades into its open position while biasing the remaining blades toward their closed positions. The locking mechanism has a single release that releases the blade that is locked into the open position. As the selected blade is opened or closed against its biasing force, the other blades remain in their closed positions under the influence of their biasing forces. Subsequently, a different blade may be selected for opening, with the same results and performance.

In the preferred form of the invention, the hand tool comprises a pliers jaw mechanism lying in a jaw mechanism plane. The jaw mechanism includes a first jaw piece having a first jaw body, a first lug extending therefrom, and a first jaw piece external lateral surface. The jaw mechanism also includes a second jaw piece having a second jaw body, a second lug extending therefrom, and a second jaw piece external lateral surface. The first jaw piece and the second jaw piece are pivotably joined together to pivot about a jaw axis between a first jaw position wherein the jaw pieces are closed together in a facing relationship, and a second jaw position wherein the jaw pieces are not closed together. The tool further includes a first handle lying

in the jaw mechanism plane and pivotably engaged by a first handle axle pin to the first lug. The first handle pivots in the jaw mechanism plane about a handle axis that is parallel to the jaw axis, between a first handle closed position wherein the first handle is adjacent to the second jaw piece, and a first handle open position wherein the first handle is extended away from the first jaw piece. The first handle has a first handle external lateral surface having a dished shape to conform to at least a portion of the second jaw piece external lateral surface. The hand tool further includes a second handle lying in the jaw mechanism plane and pivotably engaged by a second handle axle pin to the second lug. The second handle pivots in the jaw mechanism plane about a handle axis that is parallel to the jaw axis, between a second handle closed position wherein the second handle is adjacent to the first jaw piece, and a second handle open position wherein the second handle is extended away from the second jaw piece. The second handle has a second handle external lateral surface having a dished shape to conform to at least a portion of the first jaw piece external lateral surface.

The first lug and the second lug have facing protrusions thereon at locations remote from the jaw bodies, adjacent to the pivotable engagements of the respective handles to the lugs. The protrusions are dimensioned so that when the jaw pieces are closed together, the tips of the protrusions overlap. An aperture is thereby defined that may be used to attach the hand tool to a key ring or the like, independently of the jaw feature so that the jaw may be provided with a faceted nut-engaging aperture.

A detent mechanism is desirably provided to urge each handle toward its respective open or closed position. A detent is distinct from a lock, wherein the handle would be positively locked into the open or closed position. In the present case, the detent for each handle is defined in relation to the handle axis. The detent includes a handle cam surface locally defining the surface of the handle and disposed laterally adjacent to the handle axis. The handle cam surface includes a closing handle cam surface having a handle cam surface first distance from the handle axis, an opening handle cam surface remote from the closing handle cam surface and at about the handle cam surface first distance from the handle axis, and an intermediate handle cam surface disposed between the closing handle cam surface and the

opening handle cam surface and being a handle cam surface second distance from the handle axis, wherein the handle cam surface second distance is less than the handle cam surface first distance. The handle cam surface second distance is from about 0.002 inches to about 0.012 inches less than the handle cam surface first distance. With this detent mechanism, the lug of the jaw piece comprises a lug cam rider surface positioned in a facing relationship to the handle cam surface and disposed to ride thereon as the handle is moved between the handle closed position and the handle open position. The opening handle cam surface terminates in a handle shoulder remote from the intermediate handle cam surface, and the lug cam rider surface includes a lug shoulder disposed to engage the handle shoulder when the handle is in the handle open position.

Other features and advantages of the present invention will be apparent from the following more detailed description of the preferred embodiment, taken in conjunction with the accompanying drawings which illustrate, by way of example, the principles of the invention. The scope of the invention is not, however, limited to this preferred embodiment.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings illustrate the invention. In such drawings:

FIGURE 1 is a top plan view of a combination tool embodying the present invention, with the handles in a closed position;

FIGURE 2 is a top plan view similar to that illustrated in FIG. 1, illustrating various blades partially or fully extended from the handles;

FIGURE 3 is a top plan view of the hand tool illustrated in FIGS. 1 and 2, with the handles in the open position;

FIGURE 4 is a detail of the area indicated by the number 4 in FIG. 1, illustrating a cam and detent structure for the handles;

FIGURE 5 is a partially fragmented perspective view of a handle of the combination tool of FIGS. 1-3;

FIGURE 6 is another perspective view of the handle of the combination tool of FIGS. 1-3, wherein a blade has been pivoted into an open

position, the locking mechanism is shown, and the handle has been inverted from the view of FIG. 5;

FIGURE 7 is an end view of the handle of FIG. 6 with all blades pivoted to their closed position, taken generally along the line 7-7 of FIG. 6;

FIGURE 8 is an elevational sectional view taken generally along the line 8-8 of FIG. 6;;

FIGURE 9 is an elevational view of a blade base;

FIGURE 10 is a perspective view of a locking mechanism housing including a locking bar designed to engage the blade base;

FIGURES 11A-E are a series of schematic elevational views of the operation of the locking and biasing mechanism as the blade is operated, wherein FIG. 11A shows the blade in the fully open and positively locked position, FIG. 11B shows the blade after manual unlocking but while biased toward the open position, FIG. 11C shows the blade at an intermediate biased toward the closed position, FIG. 11D shows the blade approaching the closed position, and FIG. 11E shows the blade in the closed position;

FIGURE 12 is a schematic elevational view of operation of the locking mechanism with two blades, one open and positively locked and the other closed; and

FIGURE 13 is a schematic plan view illustrating a blade in a closed position within the handle.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

As shown in the drawings for purposes of illustration, the present invention is concerned with a combination tool, generally designated by the reference number 20. The combination tool 20 includes a jaw mechanism 22 having a first jaw piece 24 and a second jaw piece 26. The first jaw piece 24 and the second jaw piece 26 are pivotably joined together at a jaw pivot 28. The first jaw piece 24 and the second jaw piece 26 lie in a jaw mechanism plane. The jaw pivot 28 permits the first jaw piece 24 and the second jaw piece 26 to pivot between a closed position (as illustrated) with the jaws in a facing relationship, and an open position.

The first jaw piece 24 includes a first jaw body 30 and a first lug 32 extending therefrom. The first jaw piece 24 has an outwardly bowed first jaw piece external lateral surface 34, whose shape is generally dictated by the shape of the first jaw body 30. The second jaw piece 26 includes a second jaw body 36 and a second lug 38 extending therefrom. The second jaw piece 26 has an outwardly bowed second jaw piece external lateral surface 40, whose shape is generally dictated by the shape of the second jaw body 36.

The jaw bodies 30 and 36 may define any type of tool with a jawed pivoting structure. Preferably, as illustrated, the jaw bodies 30 and 36 cooperatively define a pliers with a grasping tip 42 and a faceted nut-grasping aperture 44. As will be discussed subsequently, the nut-grasping aperture 44 is not used for attachment of the hand tool to a key ring, and it therefore may be furnished with facets useful in grasping a nut or other object. A wire cutter 46 is formed by regions of reduced thickness adjacent to the nut-grasping aperture 44. The jaw bodies 30 and 36 could instead cooperatively define other types of jawed, pivoting structures, such as a scissors, a wire stripper, or other type of pliers.

A first protrusion 48 extends from the first lug 32 toward the second lug 38 at a location remote from the first jaw body 30. A second protrusion 50 extends from the second lug 38 toward the first lug 32 at a location remote from the second jaw body 36. The first protrusion 48 and the second protrusion 50 are in a facing relationship to each other and overlap when the jaw mechanism 22 is closed. When the jaw mechanism 22 is closed, as illustrated in FIGS. 1-4, the first protrusion 48 and the second protrusion 50 cooperatively define an aperture 52. When the jaw mechanism 22 is closed and the handles are folded and detented into the closed position, as in FIG. 1, the aperture 52 is locked closed such that it may be used to attach the hand tool 20 onto a key ring or other ring.

Two handles 54 and 54' forming channel sections, are deployably connected to the jaw mechanism 22. The first handle 54 is pivotably engaged by a first- handle axle pin 55 to the first lug 32. The first handle 54 may thereby pivot in the jaw mechanism plane between a first-handle closed position illustrated in FIGS. 1 and 2, where the first handle 54 lies immediately adjacent to the second jaw piece 26, and a first-handle open position

illustrated in FIG. 3, where the first handle 54 is extended away from the first jaw piece 24 and the second jaw piece 26.

The first handle 54 has a first-handle external lateral surface 56 with a dished shape 58. The dished shape 58 serves two purposes. When the first handle 54 is pivoted to the closed position as illustrated in FIGS. 1 and 2, the dished shape 58 closely conforms to the second jaw piece external lateral surface 40, so that there is a close fit between the first handle 54 and the second jaw piece 24. This close fit permits the combination tool 20 to be compact in its closed state. When the first handle 54 is pivoted to the open position as illustrated in FIG. 3, the dished shape 58 provides a sculpted grip that is comfortable to hold and allows the user to apply a substantial force to the jaw mechanism.

The second handle 54' is pivotably engaged by a second-handle axle pin 55' to the second lug 38. The second handle 54' may thereby pivot in the jaw mechanism plane between a second-handle closed position illustrated in FIGS. 1 and 2, where the second handle 54' lies immediately adjacent to the first jaw piece 24, and a second-handle open position illustrated in FIG. 3, where the second handle 54' is extended away from the first jaw piece 24 and the second jaw piece 26.

The second handle 54' has a second-handle external lateral surface 56' with a dished shaped 58'. The dished shape 58' serves the same purposes as the dished shape 58 of the first handle 54, discussed above.

A desirable feature of the combination tool 20 is the ability to controllably retain the handles 54 and 54' in the open position or the closed position with a mild retention force that initially resists movement away from the respective position but then is overcome with sufficient force so that the handle may be rotated. This mechanism is generally termed a "detent" mechanism. A detent mechanism is distinct from a positive lock which must be unlocked before the handle can be pivoted. The closing detent mechanism holds the handles in the closed position so that they do not unintentionally open in the pocket of the user and also so that the aperture 52 does not unintentionally open when it is retained to a key ring. The opening detent mechanism holds the handles in the open position so that the user of the tool may conveniently operate the jaw mechanism. Many detent mechanisms are

known in the art, but some are relatively expensive and others are structured so that, if the hand tool were scaled to a small size, the detent mechanism would be too small and fragile to be practical.

Both handles 54 and 54' are provided with a detent structure, and only one will be described in detail with the understanding that the other is identical. FIG. 4 illustrates the detent mechanism for the first handle 54. In FIG. 4, the axle pin 55 is removed to reveal a first pivot aperture 60 through the first handle 54.

The end of the first handle 54 adjacent to the first pivot aperture 60 is locally contoured to form a first-handle cam surface 62 which is disposed laterally adjacent to the first pivot aperture 60. The first-handle cam surface 62 has three separate but continuous regions. A closing first-handle cam surface 64 is positioned at a first distance R_1 from the first pivot aperture 60. An opening first-handle cam surface 66 is remote from the closing first-handle cam surface 64 and generally spaced about 165 degrees away from the closing first-handle cam surface 64. The opening first-handle cam surface 66 is positioned at a second distance R_2 from the first pivot aperture 60. The value of R_2 is about the same as the value of R_1 in the preferred embodiment. An intermediate first-handle cam surface 68 is disposed between the closing first-handle cam surface 64 and the opening first-handle cam surface 66. The intermediate first-handle cam surface 68 is positioned at a third distance R_3 from the first pivot aperture 60. The difference between the values of R_3 and R_1 determines the force required to move the first handle 54 from the intermediate position to the closed position, and the difference between the values of R_3 and R_2 determines the force required to move the first handle 54 from the intermediate position to the open position. The value of R_3 is less than the value of R_1 and R_2, by an amount of from about 0.002 inches to about 0.012 inches, and most preferably by an amount of about 0.008 inches. These relative values may be selected to produce the desired closing and opening force characteristics.

A "back" side 70 of the opening first-handle cam surface 66, remote from the intermediate first-handle cam surface 68, is positioned at a fourth distance R_4 from the aperture 60. A "back" side 72 of the closing fist-handle cam surface 64, remote from the intermediate first-handle cam surface

68, is positioned at a fifth distance R_5 from the aperture 60. The value of R_4 is less than the value of R_2, and the value of R_5 is less than the value of R_1. The greater the difference between the value of R_4 and R_2, the greater the retention force holding the handle 54 in the open position. The greater the difference between the value of R_1 and R_5, the greater the retention force holding the handle 54 in the closed position. The differences are preferably from about 0.002 inches to about 0.012 inches, and most preferably about 0.004 inches.

The shapes of the cam surfaces 64, 66, 68, 70, and 72, and the transitions between the cam surfaces 64 and 68, and between the cam surfaces 66 and 68, may be relatively gradual or more steeply inclined, depending upon the exact nature of the detenting force that is desired. In the embodiment of FIG. 4, the side of the cam surface 64 remote from the cam surface 68 is relatively steeply inclined at an incline surface 74 having an angle of about 30 degrees to the local radius. The transition between the cam surfaces 66 and 68 is gradual, and no relatively narrow point of transition can be easily identified.

The first lug 32, which is pivotably joined to the first solid body handle 54 at the first pivot aperture 60 (by the first handle axle pin 55), has a first-lug cam rider surface 76 positioned in a facing relationship to the first-handle cam surface 62. The first-lug cam rider surface 76 rides along the first-handle cam surface 62 as the first handle is rotated between the first-handle closed position and the first-handle open position. When the first handle 54 is in or rotationally near its closed position as illustrated in FIGS. 1 and 2, the interfering cam relationship tends to urge the first handle 54 toward the closed position. When the first handle 54 is in or rotationally near its open position as illustrated in FIG. 3, the interfering cam relationship tends to urge the first handle 54 toward the open position. In both cases, the urging force can be overcome by rotational force applied by the user. The previously discussed shape of the cam surface 62 is selected so that the required rotational force is sufficiently large so as to provide a sufficient retaining or detenting force, but not so large that the required force to overcome the detent is uncomfortable for the user. The differences between the values of R_1 and R_2, on the one hand, and value of R_3, on the other, determines the force required to move the

handle 54 to the respective closed or open position. A difference value of about 0.008 inches has been found to provide the best compromise between these competing considerations. The shape of the intermediate first-handle cam surface 68 may be selected to give any desired "feel" to the opening and closing motion. Preferably, the intermediate first-handle cam surface 68 is of approximately constant distance from the aperture 60 from near the closing first-handle cam surface 64 and near the opening first-handle cam surface 66 so that the force required to rotate the handle 54 through this region is approximately constant to provide a smooth rotational feel for the user.

The closing camming action is provided by the contact between the first-lug cam rider surface 76 and the closing first-handle cam surface 64. The relatively steep inclination angle, preferably about 30 degrees, of the first-lug cam rider surface 76 is selected to provide a positive retention detenting force in the closed position yet also produce a distinct and controlled spacing S_1 between the first handle 54 and the first lug 32, and a distinct and controlled spacing S_2 between the dished shape 58 of the first handle 54 and the second jaw piece external lateral surface 40, when the first handle 54 is in the closed position as shown in FIG. 4. In one preferred embodiment, S_1 is about 0.005 inches and S_2 is about 0.010 inches. This design approach produces a face of the combination tool with a close spacing between the handles and the jaw mechanism, so that the face is substantially continuous and coplanar. Secondly, when the combination tool is manufactured, there are inevitably small dimensional variations. During the service life of the tool, the mechanism may wear with repeated use. The described approach of the relation between the first-lug cam rider surface 76 and the closing first-handle cam surface 64 results in retention of a smooth camming action and a close fit, as exemplified by the values of S_1 and S_2, both initially and after extended service.

A first-handle stop shoulder 78 is preferably provided at the end of the opening first-handle cam surface 66 remote from the intermediate first-handle cam surface 68. A cooperating first-lug stop shoulder 80 is provided at the end of the first-handle 54. When the first handle 54 is pivoted to the open position, the stop shoulders 78 and 80 contact each other to limit the extent of rotation. When the first handle 54 and the second handle 54' are

grasped to operate the jaw mechanism 22, the grasping force is reacted through the shoulders 78 and 80, providing a strong, secure grip.

In the combination tool 20 and those available commercially, it is common practice to affix a plurality of blade tools 82 in each of the handles 54 and 54' to increase the utility of the combination tool. The blade tools 82 are pivotably connected by a tool pivot axle 84 to the handles 54 and 54' at the ends remote from the pivot pins 55 and 55'. Each of the blade tools 82 can be closed to lie within the channel sections of the handles 54 and 54' or opened to extend from the respective handle to perform their function or positioned at an intermediate position, as shown in FIG. 2. When the term "blade" or "blade tool" is used herein in reference to deployable tools received into the handle of the combination tool or other type of tool, it refers to any relatively thin tool that is folded into the handle, regardless of the utilization of the tool. Such a "blade" therefore includes, but is not limited to, a sharpened knife blade, a serrated blade, a screwdriver, an awl, a bottle opener, a can opener, a saw, a file, etc. This terminology is used to distinguish the tool folded into the handle from the overall hand tool, in this case of the combination tool 20.

The combination tool 20 has at least two, and more typically three or more of the blade tools 82 arranged on the axle 84 of each handle 54 and 54', as seen in FIGS. 2 and 5 for the case of three blade tools 82a, 82b, and 82c, all of which open in the same rotational direction. FIG. 5 also shows the channel-shaped section of the handle 54, having two sides 86a and 86b and a web 88 connecting the two sides 86a and 86b. The tool pivot axle 84 extends between the two sides 86a and 86b.

In the preferred approach, one of the sides 86a has a cut-down region 90 to permit easy manual access to the blade tools 82 when they are to be opened. The blade tools 82 are arranged so that the longest of the blades 82c is adjacent to the side 86b which is not cut-down, and the shortest of the blades 82a is adjacent to the side 86a having a cut-down region 90.

FIG. 6 illustrates the handle 54 in a view inverted from the FIG. 5 and with one of the blade tools 82c opened by rotating it on the pivot axle 84. In normal use, only one of the blade tools 82 is opened at a time, with the others remaining closed and within the handle 54. If the generally flat blade

tools 82 were positioned too closely adjacent to each other in a touching contact, as is the case in some commercially available combination tools, the friction between the touching surfaces of adjacent blade tools would tend to cause a blade tool to be unintentionally dragged open as one of the other blade tools was intentionally opened. In the present approach, illustrated in FIG. 7, a washer 92, is placed between each pair of blade tools 82 and between the last blade tool on the axle and the interior of the side 86 of the handle 54. Because the width dimension D of the handle 54 is typically small, on the order of about ½ inch, conventional thick metal washers are preferably not used. Instead, the washer 92 is preferably made of a polymeric material, most preferably polypropylene, polyethylene, or polytetrafluoroethylene (Teflon), about 0.010 inch thick. Such washers can be prepared economically by a cutting or stamping process on a sheet of Teflon adhered to a substrate carrier with a pressure-sensitive adhesive, to produce annular washer shapes. The individual washers are peeled off the substrate carrier and affixed to the opposite sides of the blade tools 82 overlying a bore 94 through which the tool pivot axle 84 passes. The washer may also be obtained as a separate article and assembled with the blade tools 82 and the axle. In another approach, the washer may be formed as a raised annular area of the blade tool surrounding the bore 94.

FIG. 8 shows a preferred form of the locking and biasing mechanism. The blade tool 82 includes a blade base 96 and an implement 98 extending outwardly from the blade base 96. The implement may be any generally flat, operable type of implement such as a sharpened knife blade (as illustrated), a serrated blade, a screwdriver, an awl, a bottle opener, a can opener, a saw, a file, etc. The implement 98 is preferably integral with the blade base 96, although it can be made detachable.

The blade base 96, shown in greater detail in FIG. 9, is generally flat and thin, on the order of about 0.05 to about 0.20 inches thick, and includes the bore 94 extending therethrough and the washer 92 around the bore. (The blade bases of the various blade tools need not be of the same thicknesses). The tool pivot axle 84 extends through the bore 94. The blade base 96 is laterally bounded generally on three sides by a peripheral surface 100, and contiguous with the implement 98 on the fourth side. The peripheral

surface 100 includes a generally straight-sided, flat-bottomed notch 102. Immediately adjacent to the notch 102, on the side remote from the implement 98, is a first cam surface 104. More remote from the notch 102 is a second cam surface 106. The first cam surface 104 is characterized by a first cam maximum surface height measured as a maximum distance to the peripheral surface 100 along a radius from the center of the bore 94 of C1 and passing through the first cam surface 104. The second cam surface 106 is characterized by a second cam maximum surface height measured as a maximum distance to the peripheral surface 100 along a radius from the center of the bore 94 of C2. In the preferred approach, C2 is approximately the same as C1, and in the preferred embodiment on the order of approximately 0.220 inches. The height of the peripheral surface is reduced between the first cam surface 104 and the second cam surface 106. In a preferred embodiment, the first cam maximum surface height of the first cam surface 104 is positioned about 6 degrees away from the adjacent edge of the notch 102. The second cam maximum surface height of the second cam surface 104 is positioned about 118.5 degrees from the first cam maximum surface height.

FIG. 10 illustrates a locking mechanism 108 which, when properly positioned over an end 110 of the handle 54 opposite its connection to the jaw mechanism 22, is movable relative to the tool pivot axle 84 to releasably lock the blade tools 82 supported therein in the open position. The locking mechanism 108 includes a lock housing 112 which is positionable on the tool handle 54 and which provides a locking bar 114 capable of engaging the notch 102 of the blade base 96 when the blade is in the open position, and a lock disengagement pad 116 opposite the locking bar 114. The lock housing further includes a pair of oppositely disposed elongated apertures 118 which slidably receive therein ends of the tool pivot axle 84. The locking mechanism 108 performs its function in connection with a cantilevered end section 120 of the web 88 which serves to bias the locking bar 114 into engagement with the peripheral surface 100 of the blade base 96.

More particularly, the lock housing 112 is situated on the tool handle 54 to be slidable relative to the tool pivot axle 84 such that the end 120 of the web 88 contacts the locking bar 114 to urge it into engagement with the

peripheral surface 100 of the blade base 96. When a selected blade tool 82 is rotated from the closed position into the open position, the locking bar 114 is configured to seat within the notch 102 and thereby prevent the blade tool 82 from being counterrotated back into its closed position without the locking bar 114 first having been displaced from the notch 102. This is accomplished by applying a force to the lock disengagement pad 116 toward the handle 54 and in the direction of the locking bar 114. Application of such a force causes slidable movement of the lock housing 112 relative to the tool pivot axle 84 to remove the locking bar 114 from the notch 102 against the biasing force of the end section 120 of the web 88. With the locking bar 114 disengaged from the notch 102, the blade tool 82 may then be rotated from its open position to the closed position within the handle 54. In the absence of a force applied to the disengagement pad 116, the end 120 of the web 88 exerts a constant biasing force against the locking bar 114 that maintains the locking bar in engagement with the peripheral surface 100 of the blade base 96.

Additionally, as can best be seen in FIG. 9, there is desirably a shoulder 122 on the implement 98 that is in facing relation to a terminal end 124 of the web 88. This engagement of the shoulder 122 to the end 124 provides an additional interference restraint of the blade tool 82 that resists rotation of the implement 98 past its fully open position. This additional restraint is particularly valuable where the implement 98 is of a type where it is forced in such a direction during service, such as a blade having a sharpened edge that is forced downwardly during cutting operations. The blade tool 82 is preferably dimensioned so that there is a gap of about 0.005 inches between the shoulder 122 and the end 124 of the web 88 when no load is applied to the blade tool. When a sufficient load is applied to produce a 0.005 inch deflection, the shoulder 122 contacts the end 124 to stop any further movement.

FIGS. 11A through 11E depict the operation of the locking/biasing mechanism in a series of views as a single blade tool 82 is moved from the open and positively locked position (FIG. 11A) to the closed and biased closed position (FIG. 11E). In FIG. 11A, the blade tool 82 is open, and the locking bar 114 is received into the notch 102, forming a positive lock of the blade tool 82 into the open position.

In FIG. 11B, the lock disengagement pad 116 has been depressed to push the locking bar 114 out of the notch 102, and the user of the tool has manually rotated the blade in a counterclockwise direction by about 10 degrees. The blade tool 82 remains biased toward the open position, because the locking bar 114 rests against the sloping cam surface 104a that slopes back toward the notch 102.

After only a slight additional rotation of the blade tool 82 in the counterclockwise direction, FIG. 11C, the locking bar 114 has passed the first cam maximum surface height location 104b and is contacting the portion of the first cam surface 104c that slopes away from the notch 102. If the blade tool 82 is released at this point, it tends to move toward the closed position rather than the open position.

Further counterclockwise rotation of the blade tool 82 brings the locking bar 114 into contact with the second cam surface 106 as shown in FIG. 11D. An additional counterclockwise rotation of the blade tool 82 brings the locking bar 114 into contact with the portion 106a of the second cam surface 106 that slopes toward the closed position and thereby biases the blade 82 toward the closed position, as shown in FIG. 11E. The blade 82 is thereby forced toward the closed position and retained there. To move the blade 82 away from the closed position, as shown in of FIG. 11E and back toward the orientation of FIG. 11D requires that the user manually overcome the bias force resulting from the reaction of the locking mechanism 108 and its locking bar 114 against the cam surface 106a.

A comparison of the effects on the blade tool 82 of the reaction between the locking bar 114 and the peripheral surface of the blade base 96 in FIGS. 11A and 11E illustrates the difference between "positive locking" of the blade tool and "biasing" of the blade tool. In FIG. 11A, the reception of the locking bar 114 into the notch 102 provides a positive lock from which the blade tool 82 cannot be moved by the application of any ordinary manual force to the blade tool 82. Intentional release of the positive lock by manually pressing the pad 116 is required in order to move the blade tool 82 from its positively locked position. On the other hand, the biasing of the blade tool 82 toward a position, illustrated for the biasing toward the closed position in FIG. 11E, is produced in the preferred embodiment by a cam action which can be

readily overcome with ordinary manual force on the blade tool. This distinction between positive locking and biasing is important. Biasing is readily achieved for blade tools 82 in a confined space, but positive locking is difficult to achieve in a confined space such as that available in a typical combination tool wherein several blade tools are supported in a narrowly confined space in each handle.

One feature of the present approach is that the blade tool selected for opening and use is positively locked into the open position, while the remaining blade tools that have not be selected remain biased toward their closed position. This feature is illustrated in FIG. 12, which superimposes views of an open and positively locked blade tool 82 and a closed and biased closed blade tool 82'. At the same time that the locking bar 114 is received into the notch 102 of the positively locked blade tool 82, the locking bar 114 rests against the slope 104a of the second cam surface 104' of the biased closed blade tool 82'. The locking bar 114 both positively locks the blade tool 82 open and biases the blade tool 82' closed. The same bias-closed effect is operable for all of the blade tools which are not open and in use. In a typical case wherein there are three blade tools such as shown in FIGS. 2 and 5-7, there is a single blade tool 82 which is open and positively locked and two blade tools 82' which are biased closed.

A further feature is that the blade tool 82' remains biased toward the closed position as the blade tool 82 is opened and closed. At an intermediate stage of rotation of the blade tool 82 between its closed and open positions, the locking bar 114 continues to rest against the slope 104a' of the second cam surface 104' of the closed blade tools 82', biasing them toward the closed position. The closed blade tools 82' therefore do not unintentionally open as the intentionally opened blade tool 82 is rotated. With this camming approach, there may be a small range of the rotation of the blade tool 82 (as the locking bar 114 passes over the top of the second cam 104) where the locking bar 114 is raised off the slope 104a' to release the biasing of the blade tools 82' toward the closed position. This small range of release of biasing is not noticeable to most users of the combination tool as they close or open the blade tool 82 in a smooth motion, and for most orientations of the tool.

Most of the discussion of the rotation of the blade tools in relation to FIG.11 has been in regard to the closing of the previously opened blade tool 82. The present approach provides an advantage when the selected blade tool 82 is being opened as well. If FIG. 13 is viewed as one moment during the opening of the selected blade tool 82 (i.e., clockwise rotation of the blade tool 82), the biasing force of the locking bar 114 on the cam surfaces 104a' tends to retain the other blade tools 82' in the closed position. The cooperation of this biasing action on the blade tools 82' and the use of the washers 92 to reduce the frictional forces between the blade tool 82 that is being manually rotated and the blade tools 82' which are to remain closed causes the blade tools 82' to either remain in the fully closed position or to rotate back to the fully closed position after a small rotation away from the fully closed position. Thus, the user of the tools is afforded the convenience of opening, positively locking, later manually unlocking, and closing any of the selected blade tools while the others of the blade tools are automatically retained in the closed position.

Although a particular embodiment of the invention has been described in detail for purposes of illustration, various modifications and enhancements may be made without departing from the spirit and scope of the invention. For example, although the locking/biasing mechanism has been discussed in relation to the blade tools of the combination tool 20, it is equally applicable to other hand tools which have openable blade tools. Accordingly, the invention is not to be limited except as by the appended claims.

WHAT IS CLAIMED IS:

1. A hand tool, comprising:

a tool body;

an axle supported at one end of the tool body;

at least one blade supported on the axle, the blade including a blade base and an implement extending from the blade base, the blade base having a peripheral surface and a bore therethrough with the axle extending through the bore so that the blade base and thence the blade is rotatable on the axle between a closed position wherein the blade is contained within the tool body and an open position wherein the blade extends from the tool body, and a notch in the peripheral surface of the blade base; and

a locking mechanism slidably movable relative to the axle, the locking mechanism including a locking bar that engages the notch of the blade base when the blade is in the open position.

2. The hand tool of claim 1, wherein the blade base includes a first cam surface on the peripheral surface of the blade base at a location adjacent to the notch having a first cam maximum surface height and a first cam maximum surface height angular position, and a second cam surface on the peripheral surface of the blade base at a location remote from the notch and having a second cam maximum surface height approximately the same as the first cam maximum surface height and a second cam maximum surface height angular position located from about 110° to about 120° from the first cam maximum surface height angular position.

3. The hand tool of claim 1, wherein the locking mechanism includes means for biasing the locking bar into engagement with the peripheral surface of the blade base.

4. The hand tool of claim 3, wherein the biasing means comprises a portion of the tool body.

5. The hand tool of claim 4, wherein the locking mechanism further includes a lock housing positionable on the tool body and having a lock disengagement pad opposite the locking bar, the lock housing being situated on the tool body to be slidable relative to the axle such that the biasing means contacts the locking bar to urge it into engagement with the peripheral surface of the blade base, but applying a force to the lock disengagement pad causes slidable movement of the lock housing to push the locking bar against the biasing means to thereby permit the locking bar to be disengaged from the notch of the blade base in order to permit the blade to be rotated from its open position to a closed position.

6. The hand tool of claim 5, wherein the lock housing includes a pair of oppositely disposed elongated apertures for receiving ends of the axle therein.

7. The hand tool of claim 1, including a plurality of blades supported on the axle, and means for biasing one of the plurality of blades towards the open position while biasing all others of the plurality of blades toward the closed position, the blade biasing means including a first cam lobe of the peripheral surface of the blade base adjacent to the notch, and a second cam lobe of the peripheral surface of each blade base remote from the notch.

8. The hand tool of claim 7, including means for at least partially rotationally isolating the plurality of blades from each other so that the rotational movement of one of the blades imparts minimum rotational forces on others of the plurality of blades.

9. The hand tool of claim 8, wherein the blade isolating means comprises a washer position between each pair of the plurality of blades.

10. The hand tool of claim 1, wherein the hand tool is a handle of a combination tool having a pair of handles deployably joined to a jaw mechanism.

11. The hand tool of claim 10, wherein the combination tool comprises:

a pliers jaw mechanism lying in a jaw mechanism plane, the pliers jaw mechanism including a first jaw piece having a first jaw body and a first lug extending therefrom, and a second jaw piece having a second jaw body and a second lug extending therefrom, the first jaw piece and the second jaw piece being pivotably joined together to pivot about a jaw axis between a first jaw position wherein the jaw pieces are closed together and a second jaw position wherein the jaw pieces are not closed together;

a first handle lying in the jaw mechanism plane and pivotable relative to the first lug between a first handle closed position wherein the first handle is adjacent to the second jaw piece and a first handle open position wherein the first handle is extended away from the first jaw piece; and

a second handle lying in the jaw mechanism plane and pivotable relative to the second lug between a second handle closed position wherein the second handle is adjacent to the first jaw piece and a second handle open position wherein the second handle is extended away from the second jaw piece.

12. The hand tool of claim 11, wherein the first handle includes a first pivot aperture therethrough and a first handle cam surface locally defining the surface of the first handle and disposed laterally adjacent to the first pivot aperture, the first handle cam surface comprising a closing first-handle cam surface at a first-handle cam surface first distance from the first pivot aperture, an opening first-handle cam surface remote from the closing first-handle cam surface and at about the first-handle cam surface first distance from the first pivot aperture, and an intermediate first-handle cam surface disposed between the closing first-handle cam surface and the opening first-handle surface and at a first-handle cam surface second distance from the first pivot aperture, wherein the first-handle cam surface second distance is less than the first-handle cam surface first distance.

13. The hand tool of claim 12, wherein the first lug comprises a first-lug cam rider surface positioned in a facing relationship to the first-handle

cam surface and disposed to ride thereon as the first handle is moved between the first-handle closed position and the first-handle open position.

14. The hand tool of claim 13, wherein the opening first-handle cam surface terminates in a first-handle shoulder remote from the intermediate first-handle cam surface, and wherein the first-lug cam rider surface includes a first-lug shoulder disposed to engage the first-handle shoulder when the first handle is in the first-handle open position.

15. The hand tool of claim 12, wherein the second handle includes a second pivot aperture therethrough and a second handle cam surface locally defining the surface of the second handle and disposed laterally adjacent to the second pivot aperture, the second handle cam surface comprising a closing second-handle cam surface at a second-handle cam surface first distance from the second pivot aperture, an opening second-handle cam surface remote from the closing second-handle cam surface and at about the second-handle cam surface first distance from the second pivot aperture, and an intermediate second-handle cam surface disposed between the closing second-handle cam surface and the opening second-handle cam surface and at a second-handle cam surface second distance from the second pivot aperture, wherein the second-handle cam surface second distance is less than the second-handle cam surface first distance.

16. The hand tool of claim 15, wherein the second lug comprises a second-lug cam rider surface positioned in a facing relationship to the second handle cam surface and disposed to ride thereon as the second handle is moved between the second handle closed position and the second handle open position.

17. The hand tool of claim 16, wherein the opening second-handle cam surface terminates in a second-handle shoulder remote from the intermediate second-handle cam surface, and wherein the second-lug cam rider surface includes a second-lug shoulder disposed to engage the second-

handle shoulder when the second handle is in the second-handle open position.

18. The hand tool of claim 11, wherein the first jaw piece includes a first jaw piece external lateral surface, the second jaw piece includes a second jaw piece external lateral surface, the first handle has a first handle external lateral surface having a dished shape to conform to at least a portion of the second jaw piece external lateral surface, and wherein the second handle has a second handle external lateral surface having a dished shape to conform to at least a portion of the first jaw piece external lateral surface.

19. The hand tool of claim 18, wherein the first lug includes a first protrusion extending toward the second lug at a location remote from the first jaw body, and wherein the second lug includes a second protrusion extending toward the first lug at a location remote from the second jaw body, the first protrusion and the second protrusion overlapping and together defining an aperture when the jaw pieces are closed together so that the first jaw body contacts the second jaw body.

20. A hand tool, comprising:

a tool body;

an axle supported at one end of the tool body;

a plurality of blades supported on the axle, each blade including a blade base and an implement extending from the blade base, the blade base having a peripheral surface and a bore therethrough with the axle extending through the bore so that the blade base and thence the blade is rotatable on the axle between a closed position wherein the blade is contained within the tool body and an open position wherein the blade extends from the tool body, and a notch in the peripheral surface of the blade base; and

a locking mechanism slidably movable relative to the axle, the locking mechanism including a locking bar that engages the notch of the blade base when the blade is in the open position, and means for biasing the locking bar into engagement with the peripheral surface of the blade base, the biasing means comprising a portion of the tool body.

21. The hand tool of claim 20, wherein the tool body comprises a pair of oppositely disposed sides interconnected by a web to form a channel for retaining the blades therein when in their closed position, and wherein a portion of the webbing provides the biasing means.

22. The hand tool of claim 21, wherein the locking mechanism further includes a lock housing positionable on the tool body and having a lock disengagement pad opposite the locking bar, the lock housing being situated on the tool body to be slidable relative to the axle such that the biasing means contacts the locking bar to urge it into engagement with the peripheral surface of the blade base, but applying a force to the lock disengagement pad causes slidable movement of the lock housing to push the locking bar against the biasing means to thereby permit the locking bar to be disengaged from the notch of the blade base in order to permit the blade to be rotated from its open position to a closed position.

23. The hand tool of claim 22, wherein the lock housing includes a pair of oppositely disposed elongated apertures for receiving ends of the axle therein.

24. The hand tool of claim 20, wherein the blade base includes a first cam surface on the peripheral surface of the blade base at a location adjacent to the notch having a first cam maximum surface height and a first cam maximum surface height angular position, and a second cam surface on the peripheral surface of the blade base at a location remote from the notch and having a second cam maximum surface height approximately the same as the first cam maximum surface height and a second cam maximum surface height angular position located from about 110° to about 120° from the first cam maximum surface height angular position.

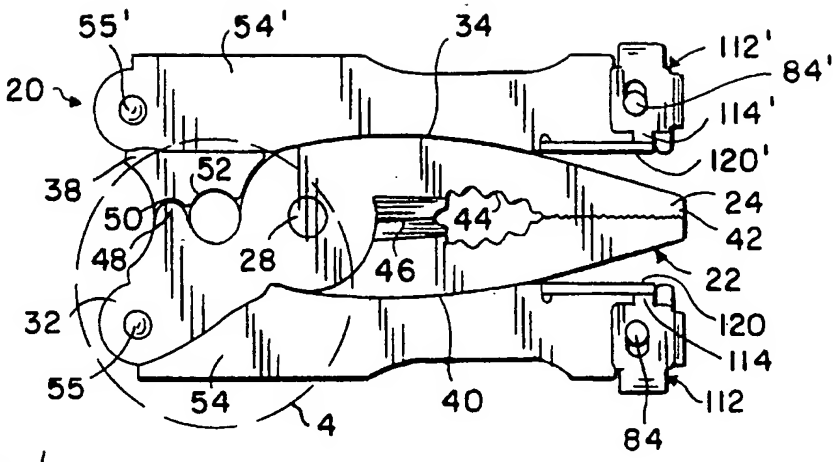
25. The hand tool of claim 20, wherein the hand tool is a handle of a combination tool having a pair of handles deployably joined to a jaw mechanism, the combination tool comprising:

a pliers jaw mechanism lying in a jaw mechanism plane, the pliers jaw mechanism including a first jaw piece having a first jaw body and a first lug extending therefrom, and a second jaw piece having a second jaw body and a second lug extending therefrom, the first jaw piece and the second jaw piece being pivotably joined together to pivot about a jaw axis between a first jaw position wherein the jaw pieces are closed together and a second jaw position wherein the jaw pieces are not closed together;

a first handle lying in the jaw mechanism plane and pivotable relative to the first lug between a first handle closed position wherein the first handle is adjacent to the second jaw piece and a first handle open position wherein the first handle is extended away from the first jaw piece; and

a second handle lying in the jaw mechanism plane and pivotable relative to the second lug between a second handle closed position wherein the second handle is adjacent to the first jaw piece and a second handle open position wherein the second handle is extended away from the second jaw piece.

26. The hand tool of claim 25, wherein the first lug includes a first protrusion extending toward the second lug at a location remote from the first jaw body, and wherein the second lug includes a second protrusion extending toward the first lug at a location remote from the second jaw body, the first protrusion and the second protrusion overlapping and together defining an aperture when the jaw pieces are closed together so that the first jaw body contacts the second jaw body.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112'
84'
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114'
120'
38
52
24
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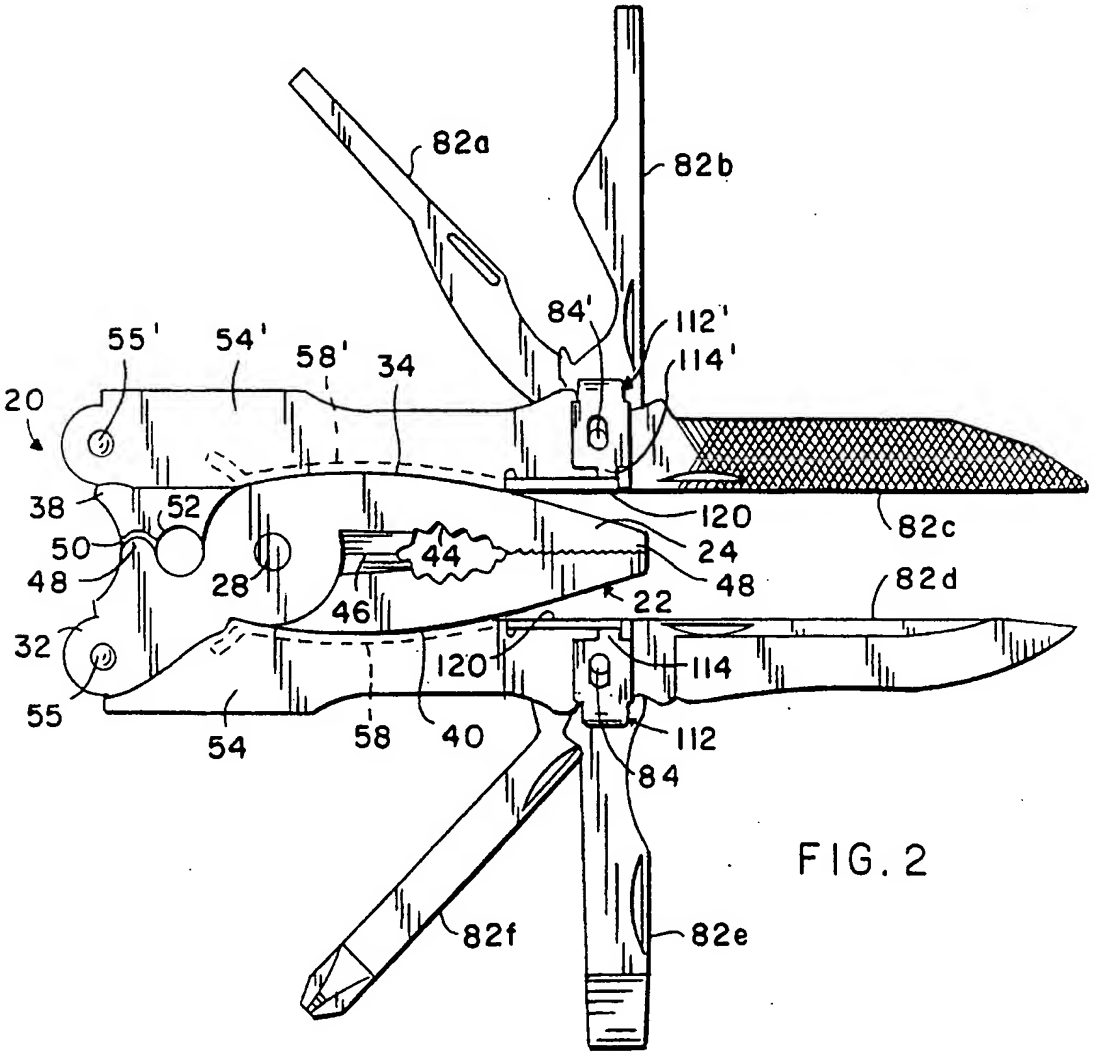
44
42
48
28
46
22
32
120
114
55
54
40
112
4
84

FIG. 1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82b
84'
112'
55'
54'
58'
34
114'
20
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52
120
82c
50
44
24
48
28
48
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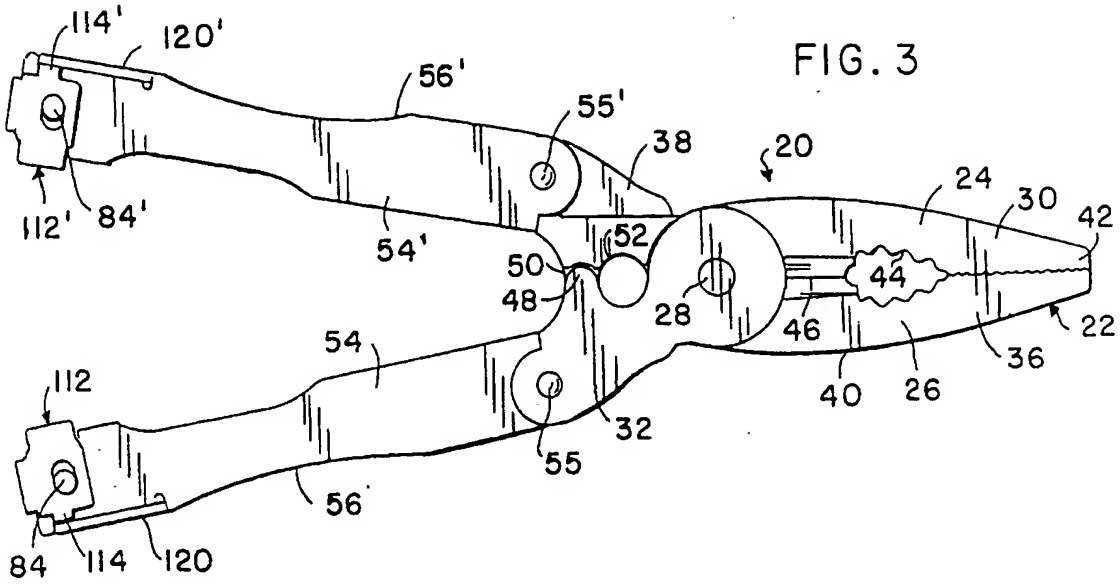
46
22
32
120
114
55
54
58
40
112
84
82f
82e

FIG. 2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120'
56'
55'
38
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24
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84'
54'
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112
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32
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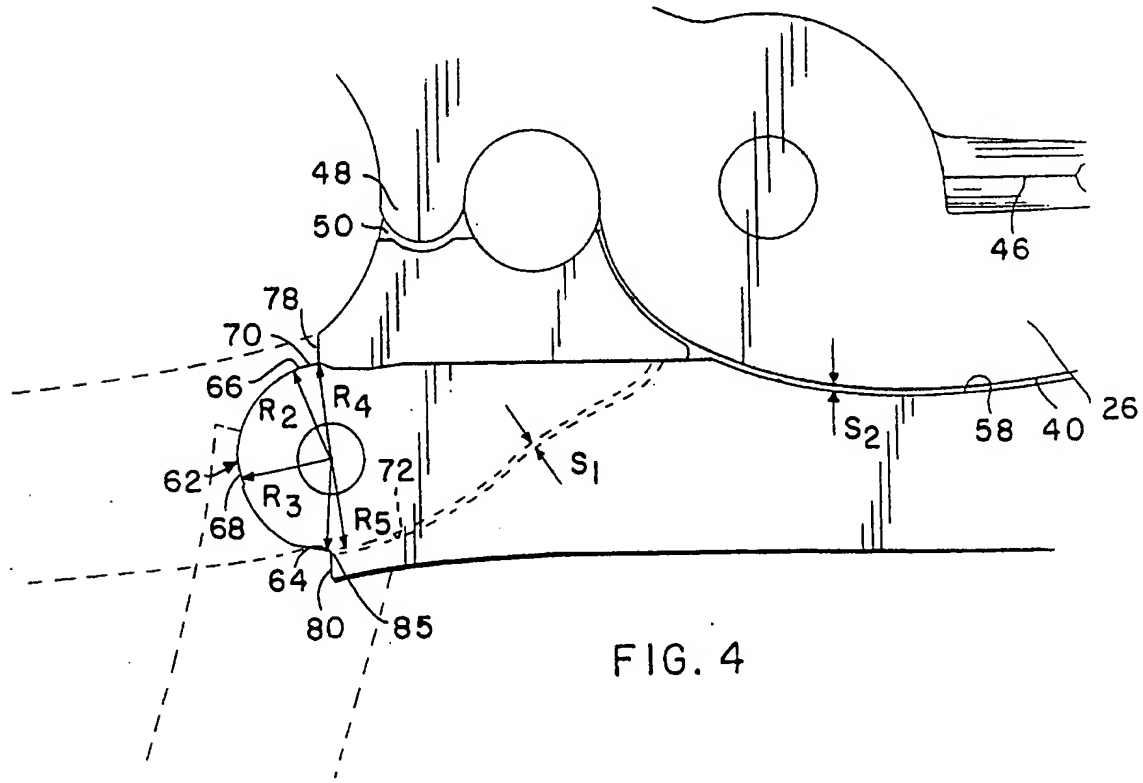
56
84
114
120

FIG. 3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46
78
70
66
R2
R4
S2
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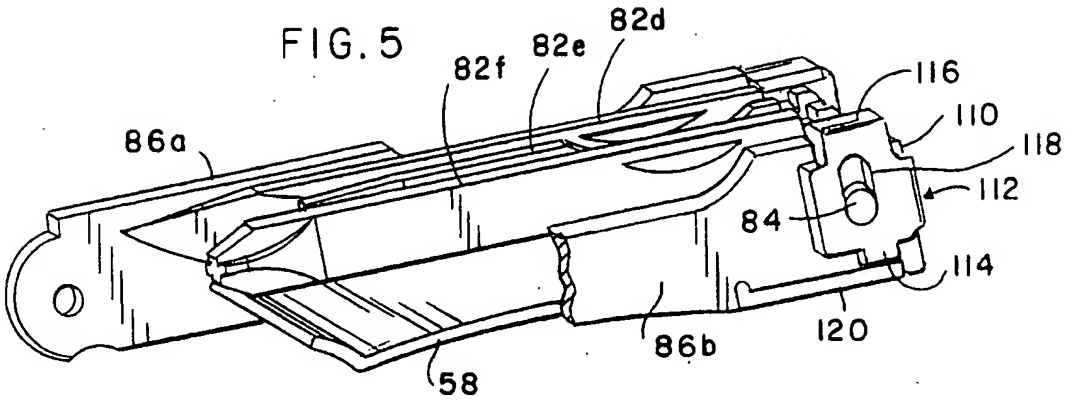
26
62
72
S1
R3
68
R5
64
80
85

FIG. 4

FIG. 5



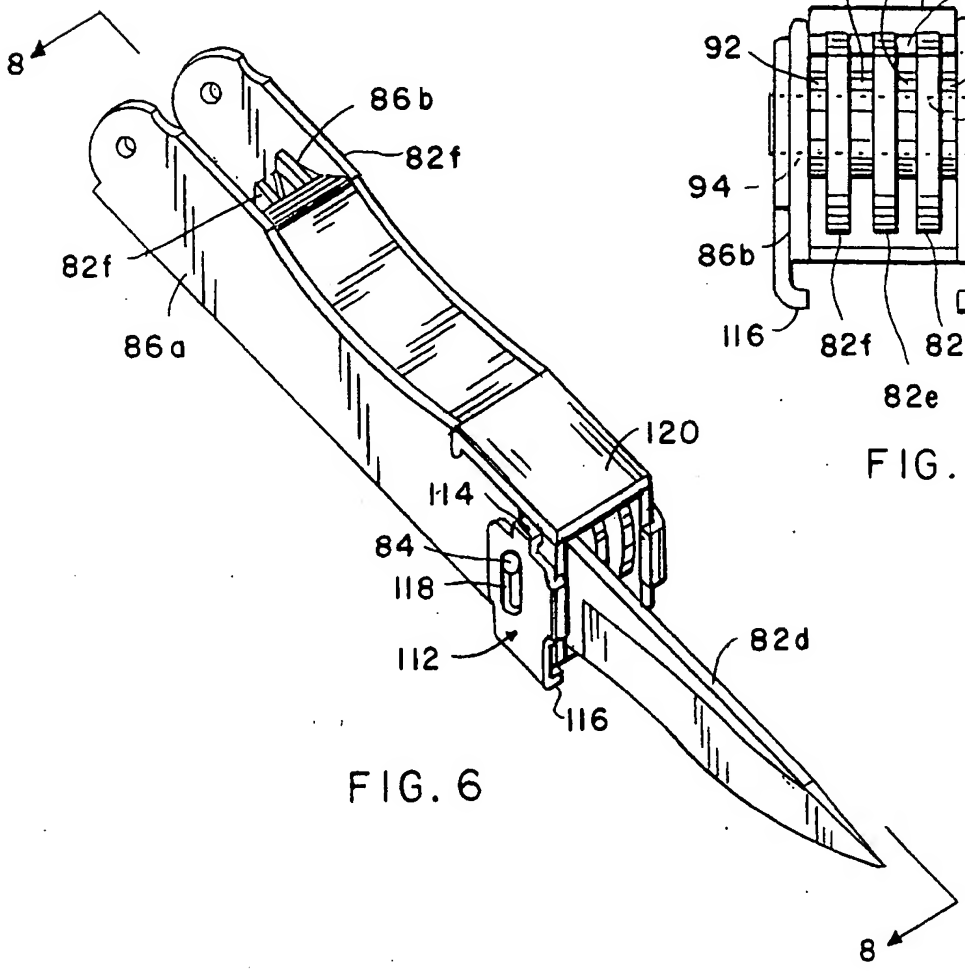


FIG. 6

FIG. 7

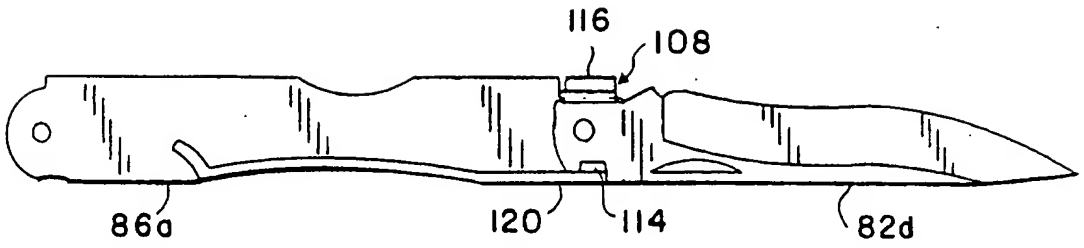


FIG. 8

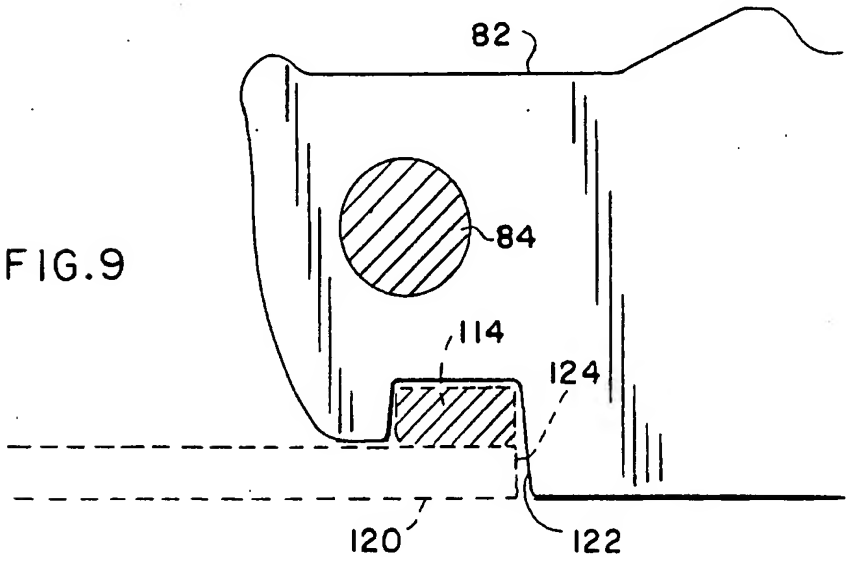


FIG. 9

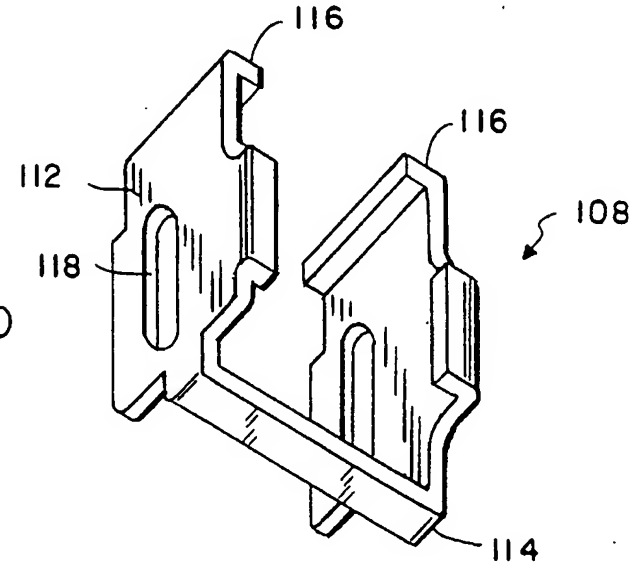


FIG. 10

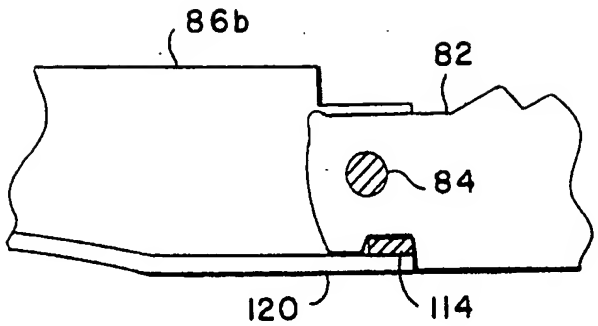


FIG. 11A

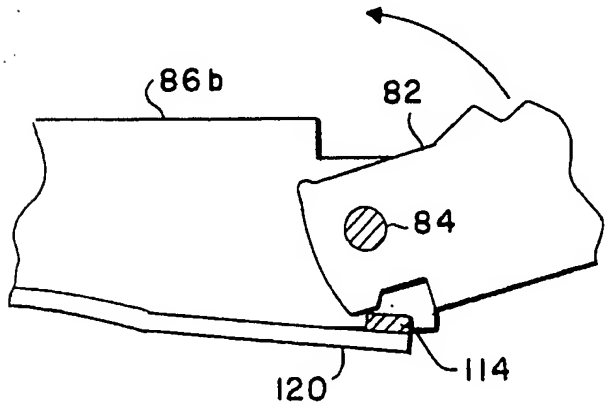


FIG. 11B

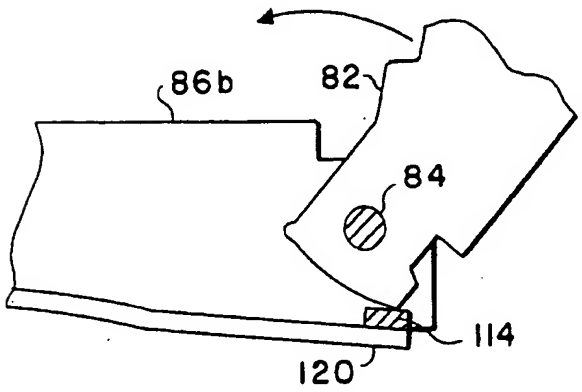


FIG. 11C

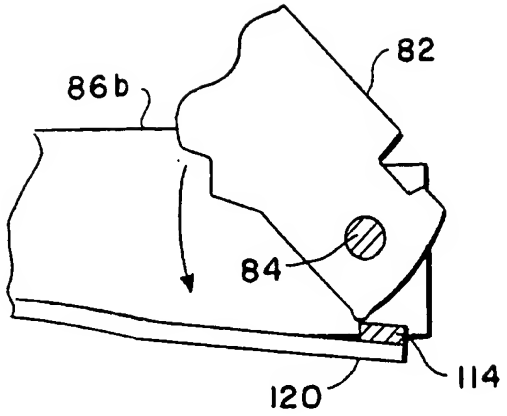


FIG. 11D

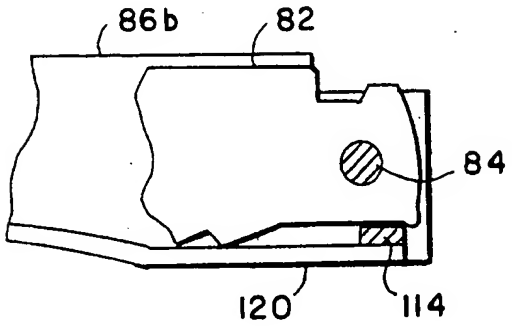
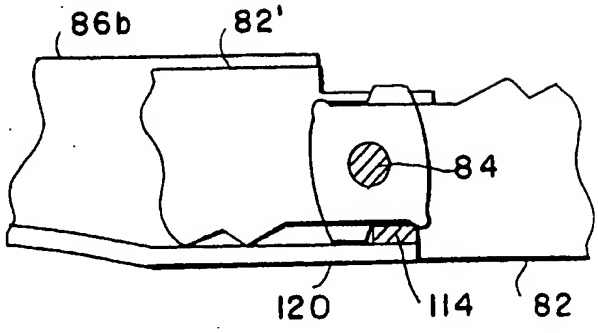


FIG. 11E

FIG. 12



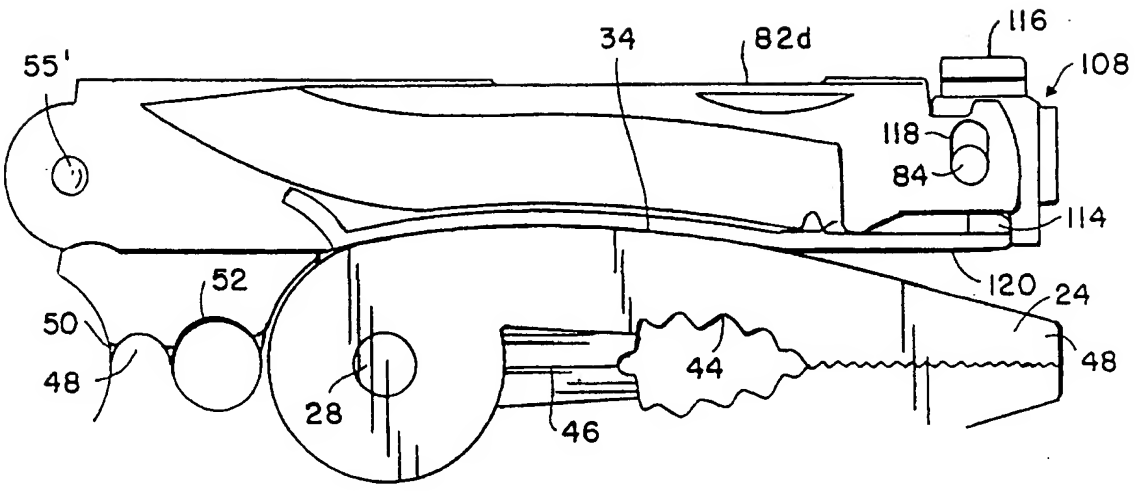


FIG. 13

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US99/01565

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :B25B 7/22
US CL :7/128; 81/427.5, 440; 30/161
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 7/125-129, 132, 165; 81/427.5, 437-440, 177.6-177.9, 177.4; 30/255, 152, 160-161

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X --- Y	US 988,068 A (BEARDSLEY ET AL) 28 March 1911, see entire document.	1-5 ------ 6
X --- Y	US 5,765,247 A (SEBER ET AL) 16 June 1998, see the abstract.	1-5, 7-11, 18, 20, 24-25 ---------- 6
X --- Y	US 4,238,862 A (LEATHERMAN) 16 December 1980, see col. 7, lines 13-37.	1-4, 7, 10-11, 20-21, 24-25 -------- 6, 22-23

[X] Further documents are listed in the continuation of Box C. [ ] See patent family annex.

*	Special categories of cited documents:	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A"	document defining the general state of the art which is not considered to be of particular relevance	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E"	earlier document published on or after the international filing date	"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L"	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&"	document member of the same patent family
"O"	document referring to an oral disclosure, use, exhibition or other means		
"P"	document published prior to the international filing date but later than the priority date claimed		

Date of the actual completion of the international search	Date of mailing of the international search report
10 MARCH 1999	24 MAR 1999

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/US99/01565

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 4,730,394 A (SONNER JR.) 15 March 1998, see col. 3, lines 41-44 and col.5, lines 27-51.	6, 22-23